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ABSTRACT

The Learning in Science Project (Primary--LISP(P)--designed to investigate the teaching and learning of science in New Zealand primary schools, arises from the work of the original Learning in Science Project (LISP). This paper is an attempt to clarify the direction of LISP(P) as it moves toward the central phase of the research. The ideas presented are derived from information available from LISP, the exploratory phase of LISP(P), and other sources. In order to establish the foundation upon which LISP(P) is to be built, basic assumptions about learners, teaching, and knowledge as related to primary school science are discussed. The view promulgated is that teaching and learning science at the primary level should help children achieve more meaningful interaction to enable them to do things and understand events. As a result, it is suggested that primary science: (1) be concerned with children's present interactions with the world rather than their future science education; (2) enable and encourage children to develop concepts; and (3) be manageable by teachers. Implications based on this view, which include guidelines for further development in LISP(P), are addressed with respect to science topics, science concepts, doing things, skills of investigation, students' explanations of phenomena, and teaching. (JN)

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LEARNING IN SCIENCE PROJECT (PRIMARY)

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A PERSPECTIVE ON PRIMARY SCIENCE

SE 045 306

Science Education Research Unit
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Hamilton, N.Z.

 Working Paper No. 104

A PERSPECTIVE ON PRIMARY SCHOOL SCIENCE

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A Working Paper of the Learning in Science Project
(Primary)

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BACKGROUND

This paper is an attempt to clarify the direction of the Learning in Science Project (Primary), LISP (P), as it moves toward the central phase of the research. The ideas arise from information available from LISP (F1-4) (Osborne and Freyberg, 1982), the exploratory phase of LISP (P) (Biddulph, 1982a, 1982b), as well as other sources.

In retrospect it is clear that the last two phases of LISP (F1-4) operated on the basis of certain beliefs about science teaching and science teachers. One of these was that secondary teachers would readily accept that at least one aim of science teaching at the Form 1-4 level is to modify children's views, or at least some children's views, toward those of scientists. This led to much of LISP (F1-4) work being based on certain implicit assumptions. The assumptions included:

(i) that findings which showed that children's ideas were not modified in the ways expected by teachers and/or which showed mismatches between intended and actual learning in the classroom, would be seen as important and significant findings which would be of central concern to teachers; and

(ii) that as a consequence of such findings teachers would be prepared to reconsider the aims and/or methods of science teaching.

Such assumptions appear to have been confirmed, by and large, in subsequent action-research and in-service training experiences.

With respect to LISP (P) these assumptions may not take on the same significance. There are several reasons for this. Firstly, primary teachers, as generalists, have wide curriculum responsibilities. Science is only one of their many teaching tasks and thus findings of a teaching-learning mismatch would not be of such central concern to them. Rather than rethinking aims and methods many teachers might simply reduce the science component of the curriculum actually provided in their classrooms.

Further, although responsible for teaching science, primary teachers are generally not very knowledgable about many science topics. Accordingly findings about mismatches between children's views and scientist's views may have less meaning for them than for their secondary colleagues.

Thirdly, there is a different approach to teaching and learning in the primary school. Primary-aged children are generally more divergent, more play-oriented and less focussed in their thinking than their secondary counterparts. They are more concerned with acting on their environment in a concrete way. Many primary teachers not only take account of this but believe that the classroom environment should give pupils opportunity to explore, both with materials and ideas, through play. The primary school curriculum is less dominated by notions of discipline-based ideas and skills which must be developed than is the secondary school curriculum.

Finally, opinion amongst science educators, nationally and internationally, about the relative importance, at the primary school level, of influencing concepts, process skills and attitudes is more divergent than at the secondary level.

In the light of this situation it is important to establish the foundation upon which LISP (P) will be built. Since there is lack of agreement about the relative significance of the various aspects of primary science we shall first make explicit our assumptions about primary school science.

PRIMARY SCHOOL SCIENCE

While LISP (P) is primarily concerned with Standards 2-4, much of what follows has applicability, we believe, to the full J1 to Form 2 range.

Our overall position is that, science programmes in the primary school should take account of both (a) the needs of primary pupils to make sense out of their natural, physical and technological environment, and (b) the desire of teachers to maintain feelings of professional competence - of being able to control the learning situation.

Learners: Our views about primary science have been influenced by many researchers (Piaget, 1966; Kelly, 1969; Wittrock, 1977; Symington, 1982; Harlen, 1982) as well as our own empirical and theoretical work (Osborne and Freyberg, 1982; Osborne and Wittrock, 1982). These have led us to place considerable importance upon the actions of pupils in relation to materials. Often these actions are purposeful. For example, young children frequently

take mechanical objects apart in order to find out how they work. Or again children enjoy being able to construct things, e.g. building a kite.

On other occasions, however, the actions seem less purposeful and could best be described simply as play. Such activity is of importance in that it is during play that the foundations of many important concepts are laid. Not only that, but Biddulph (1982a), in the initial stages of LISP (P) has shown the importance of activity with concrete materials in determining the attitude which pupils have to classroom science.

Further, reflection upon our experiences and the literature has led us to firmly support the view that learners construct meaning for themselves as they attempt to make sense of their interactions with objects and people. Construction of personal knowledge begins at birth and continues through life.

In the primary years children attempt to make sense of their world by seeking to find patterns and regularities in their experiences. As they develop they not only use these constructions to understand themselves, their surroundings and their potentialities, but also they test the utility of these constructions against such criteria as the successful prediction and control of events (Kelly, 1969).

Our basic premise, then, is that children do things, ask questions of themselves and others and seek to make sense of their world. With respect to science we are concerned primarily with events in the physical, natural and technological world. For the younger child this world is his or her immediate environment which expands as the child broadens his or her first-hand and vicarious experiences.

Teaching: On the basis of the above we would argue that teaching science in the primary school should help children to achieve more meaningful interaction with their world. Meaningfulness has two aspects, viz, being able to do things, and being able to make sense of the world. We would argue that the development of both aspects should be possible at the primary level.[1] Of

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1. Meaningful interaction involves process and content. By adoption of the concept of meaningfulness as a guiding principle, arguments about how much emphasis should be placed on one or the other may become unnecessary.

course the possibility of achieving the above is not of itself sufficient. Any programme must be able to be implemented in such a way that teachers themselves gain greater understanding, prediction and control of events in their classroom.

Knowledge: Learning and teaching are embedded in a society based on a certain history and culture. In terms of science this leads to a third consideration. In the early primary school years children need to have opportunities to handle objects, to observe what happens, and to restructure their knowledge in ways that are straight forward extensions of the knowledge they already have. However, we need to appreciate that this knowledge, developed through personal experience and individual thought - sometimes called physical (Kamii and De Vries, 1978), or intuitive (Strauss, in press), knowledge - can be quite different from knowledge as understood by scientists. All the personal experiences and individual thought of a lifetime are unlikely to lead to a construction which bears any real resemblance to the knowledge based on the collective experiences and thought that form our scientific history and technological culture. Although the boundary between intuitive and scientific knowledge is not clear the failure to attempt to distinguish between them has led to much confusion in science teaching. For example, sometimes teachers have expectations that particular first-hand experience will lead to certain scientific knowledge, rather than the intuitive knowledge which the child constructs from it. While we need to help younger children to act on, observe, and attempt to understand their immediate world in their own way as they grow, we also need to help them:

(i) appreciate and be interested in a wider view of the world; and

(ii) be interested in other people's explanations of the world and how such explanations have been obtained.

We need to help children develop doing and thinking abilities which will enable them to evaluate in terms of plausibility, intelligibility and usefulness (Hewson, 1981) the explanations of others and, where appropriate, to modify their views in the light of this evaluation.

The art of helping children towards adopting scientific ideas, based on our history and our culture, in place of their earlier ideas should not be an overriding aim of primary science. However, we must not ignore this longer term goal of science education. Rather it should be one consideration when we come to decide what aspects of the pupils' world we want to encourage primary

children to investigate, what ways of investigating we want to encourage, and what types of understandings we want children to seek and use at any particular time.

Summary: Our view of teaching and learning science at the primary school level is that it should help children to achieve more meaningful interaction with the world in the sense that it should enable them to do things and to understand events. There are three consequences of this view.

(a) Primary science should be centrally concerned with the child's present interaction with the world rather than his/her future science education. We want children to investigate things, to explore ideas and to seek and develop understandings which are sensible and useful to them.

(b) Notwithstanding the above, primary science should, where possible, enable and encourage children to develop concepts which can be related to important and fundamental scientific ideas and skills at a later point in their education. Sometimes a child will seek out and really appreciate certain scientific ideas, and ways of doing things, at a relatively young age. Sometimes children will even change their ideas because they have sought out scientific ideas and these ideas are seen as more plausible, intelligible and useful than their earlier ideas. Where this is a natural development and is not forced it should be encouraged.

(c) Primary science needs to be manageable by teachers in that teachers must feel that they have control over the teaching situation. Primary science programmes should enable teachers grow in confidence through helping them to better understand, predict and control events in their classrooms. This includes providing teachers with: (a) a better understanding of both children's intuitive knowledge, and the knowledge of scientists; (b) knowledge of what things children are interested in doing and learning about; and (c) a clear idea of what activities and teaching-learning procedures are appropriate.

If the experience of teaching science does not help the teacher in these ways science will not be taught in primary schools.

IMPLICATIONS

This view of primary science has certain implications for the teaching and learning of science. These include implications with respect to:

Topics: The topics chosen should be 'close to children'. By this we mean that the phenomena are part of the child's immediate world and that they are phenomena about which the child is interested, asks questions and can form real understandings (e.g. the growth of plants). This entails more than choosing topics on the basis of what we think children will be interested in.

Concepts: We define concepts as regularities perceived in objects or events and usually identified with a label. In this paper we are interested in concepts associated with views of the natural, physical and technological world, and the meaning for words (the labels) used to describe these views. If we are to help children develop their concepts then we need criteria to decide which concepts we should emphasise within topics. We consider (see Harlen, 1982) that they should be:

(a) within the grasp of children and help the understanding of every- day phenomena; i.e. those ideas which children can apply and consolidate through studying their immediate environment;
(b) those which are attainable through simple investigations, using equipment, materials and reference books available in schools.

Our treatment of concepts should take into account recent research[2] which shows how inappropriate concepts appear to be giving rise to major conceptual problems in the thinking of older children. We believe that an approach which sets out to clarify and extend science concepts in a way which helps children make sense of their world will form a useful base not only for life but also for later secondary education.

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2. LISP (F1-4), together with research carried out in other places, has shown that children are entering secondary school with inappropriate concepts (e.g. see Bell, 1981).

Doing Things: It has been argued that primary science should give pupils a more meaningful interaction with their world, and that such interaction involves in part, being able to do things. Doing may be playful or purposeful. It may involve making things, e.g. making a mirror. It may involve exploring the properties of matter, e.g. building with wood. It may involve exploring the behaviour of living things. Sometimes it will have potential for developing manipulative and creative skills. If the activities give rise to questions and events that children want to understand so much the better.

Skills of investigation: We would agree with Harlen (1982) who argues that concepts, skills and attitude development all benefit if the process skills are employed in relationship to content from which the child can make better sense of his or her world. Earlier too, we argued that concepts to be developed should be accessible through simple investigation using materials. However, whilst being firmly committed to 'hands-on' enquiry as desirable wherever appropriate, we are aware than an earlier study (Symington, 1977) has shown that over 50% of the questions that Australian Grade 6 (Standard 4) children asked about five scientific phenomena were not accessible through hands-on enquiry. We believe that if useful answers to such questions can be found by reference to some sort of information (e.g. a book, an adult) these questions should be pursued.[3]

Moreover, Tasker (1981) has shown that even older (secondary) pupils do not always see current classroom investigations as a means of helping them to a better understanding of their world. Part of the answer to this problem is to improve the link in secondary school between the investigations in which the pupils are involved and the scientific ideas being considered. However it would be a useful start if primary pupils came to an understanding of the relationship between investigations and developing sound ideas about their natural environment. An approach such as this, in which pupils are enabled and encouraged to be involved in investigations of questions which are relevant to them, should therefore be seen as a constructive preparation both for life and for later science education.

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3. An example of such a question, taken from the Symington (1977) study, is "How is glass made?"

Explanations: We believe that the forms of explanation expected of, and used with, children should be those that match their understanding of the world and their current thinking abilities. As yet there has been little formal study of this aspect of children's science and it will be proposed later that such a study should be undertaken.

The type of understandings children see as appropriate will obviously influence the way they process incoming information and the questions they see as significant. An earlier study (Osborne and Gilbert, 1980) showed that certain types of explanation tend to be used by children and these may well need modification. Examples are those which

(i) use self-centred and human-centred views where these are inappropriate;
(ii) attribute animal characteristics to inanimate objects; and
(iii) treat abstract ideas as having material existence.

The extent to which pupils see their own understandings as adequate will also influence both their motivation to seek alternative views and their readiness to accept alternative views.

Finally, we need to appreciate that both children and scientists are interested in, and satisfied by, a range of forms and levels of understanding, depending on their particular interests and needs at a given time.

Teaching: Tasker (1981) and more recently Biddulph (1982b) have shown that in many classrooms pupils do not have the opportunity to interact with the physical and natural world in a way that is meaningful to them. The questions raised in pupils' minds at the beginning of a new topic are not the ones the teacher focusses on. The investigations which children are asked to carry out relate to the teacher's focus. Children rarely get an opportunity to investigate their problems, to develop their understandings, to have their understandings treated seriously and discussed. It is rare too for children to do things under the name of science that leads them to a feeling of satisfaction and achievement in the realm of technology, construction science, or animal husbandry.

One of the reasons for this, at the primary level, is that we have not yet found a way to achieve this goal with teachers whose own ability to interact meaningfully with the physical, natural and technological world is somewhat

limited. If this lack of control[4] also relates to the classroom management in a whole variety of ways, exacerbated by a lack of equipment and other resources, then it is not surprising that teachers maintain control of their classrooms by excluding science from the curriculum.

As mentioned before an important aim of future curriculum development is to find a way that teachers can develop greater control of their technological, physical, natural and social worlds at the same time as children achieve more meaningful interaction with their physical, natural and technological worlds. Is this an impossible task? Possibly it is, but at least the challenge is clear.

TOWARDS FURTHER DEVELOPMENT IN THE LISP (P)

The previous analysis presents in our view guidelines for the Learning in Science (Primary). These include:

Topics: There is a need to consider what topics should form the central core of primary school science. In the context of LISP (P) one consideration must be the Resource Units presently available to teachers.

This requires data to be gathered on:

(i) the topics which are close to children in that they accept them as part of their own immediate world and include phenomena about which children can and do ask questions and form meaningful understandings;

(ii) the topics which children perceive as providing them with an opportunity to do things;

(iii) the topics which teachers find manageable and successful.

Concepts: In association with the topics considered above, and in association with the criteria set out for the choice of concepts earlier, it may be desirable to identify important concepts. In view of LISP (F1-4) it would appear desirable to establish for these concepts information about children's views, scientist's views, and the views of teachers on their concepts.

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4. Here the word 'control' is being used in the sense of being able to do things within the class and explain what goes on in the classroom.

Doing Things: We need to know what things children like doing. We need to establish which activities, or types of activities, give rise to pupils raising questions and seeking understandings; questions and understandings which are manageable in the school setting.

Skills of investigation: We need to know what questions children ask and what sort of understandings they seek. Also we need to know how children go about seeking understandings not only in pupil-directed but also in teacher-directed investigations. Are the skills of investigation that children have, appropriate and adequate for them to arrive at the sort of understanding they seek? Are school resources in terms of books and equipment adequate[5] for children to carry out an investigation successfully?

Explanations: We need to know not only what questions children ask, what sort of understandings they seek, and how they go about seeking understandings, but we also need to know what sorts of understandings they use, think adequate, and accept as sound. Another part of this, which is related to our earlier discussion on topics and concepts, is to find out what sorts of phenomena they want to understand, or should want explained. Other questions include what sorts of phenomena would children perceive scientists wanting to understand, what would children perceive a scientist's understanding to be like, how do they think a scientist would obtain understanding, and what form of explanation is appropriate for teachers to give children?

Teaching: At some stage of the Project we will need to give serious consideration to how we provide a classroom environment in which not only pupils gain satisfaction, in that they develop more meaningful interaction with the natural, physical and technological world, but also in which teachers gain satisfaction in that the ways of teaching that we propose help them to develop a greater control over their world. Here we mean control in the sense of being able to do things and explain things not only in the natural, physical, and technological world but also in the social world of the classroom.

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5. Adequacy can be considered from a number of points of view: adequate as perceived by the pupils, by the teachers, or by scientists.

In the Appendix these considerations have been translated into an initial set of research questions.

REFERENCES

Bell, B.F. When is an animal, not an animal? Journal of Biological Education, 1981, 15(3), 213-218

Biddulph, F. Primary Science. the views of teachers and pupils LISP(P) Working Paper No. 102, Hamilton, New Zealand, S.E.R.U. University of Waikato, 1982(a)

Biddulph, F. Primary Science: a view of the classroom LISP(P) Working Paper No. 103, Hamilton, New Zealand, S.E.R.U. University of Waikato, 1982(b)

Harlen, W. Basic concepts and the primary/secondary science interface, Chelsea, C.S.E., University of Lordon, 1982

Hewson, P.W. A conceptual change apprcach to learning science, European of Science Education, 1981, 3(4), 383-396

Kamii, C. and De Vries, R. Physical Knowledge in Pre-School Education, Englewood, Cliffs, N.J., Prentice Hall, 1978

Kelly, G.A. Ontological acceleration. In Maher, B. (Ed), Chemical Psychology and Personality: The selected papers of George Kelly, N.Y., Wiley, 1969

Osborne, R. and Freyberg, P. Learning in Science Project (Form 1-4): Final Report, Hamilton, S.E.R.U., University of Waikato, 1982

Osborne, R.J. and Gilbert, J.K. A technique for exploring students' view of the world Physics Education. 1980, 50(6), 376-379

Osborne, R.J. and Wattrock, M.C. Learning Science: a generative process, Los Angeles, G.S.E., U.C.L.A., 1982

Piaget, J. The child's conception of physical causality, Totowa, N.J., Littlefield, Adams, 1966

Strauss, S. (Ed) U Shaped Behavioural Growth, Academic Press (Developmental Psychology Series (in press)

Symington, D. Primary School Pupils' ability to see scientific problems in everyday phenomena Research in Science Education, 1977, 7, 41-50

Symington, D. Treatment of Content in primary science courses Australian Science Teachers Journal, 1982, 28(1), 31-36

Tasker, C.R. Childrens views and classroom experiences Australian Science Teachers Journal, 1981, 27(3), 51-57

Wittrock, M.C. Learning is a generative process. In M.C. Wittrock (Ed), Learning and Instruction, Berkeley, McCutcheon, 1977, 621-631

Appendix : Toward a list of research tasks

Pupil Interviews (including observational interviews)

What sorts of things do children like doing?
What questions do children ask of themselves with respect to particular topics?
What questions do children want answered?
What sorts of understandings do children seek?
How do children go about seeking understanding?
Do children have the skills to go about obtaining the type of understanding they seek?
What sorts of explanations do children think adequate and recognise as good?
What is their concept of a scientist's explanation?
For what topics can children form useful understandings?

Parent Interviews (as above plus)

What sorts of explanations satisfy children?

Teacher Interviews (as above plus)

What topics do teachers find manageable and successful?

Classroom observation

Which activities, or type of activities, give rise to pupils questioning and seeking understandings, which are manageable in the school setting?
(see also pupil interviews for questions to which they may also find answers through classroom observation).

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